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ABSTRACT

Based on an extensive review of literature on the depth of comprehension approach, a study was conducted to induce various degrees of depth of processing at the semantic inferential level through orientation tasks. It was hypothesized that the most superficial reading would occur for "error correction" and the deepest reading would be done for "critical evaluation." In between the two would lie "summarization," "reproduction," and "comprehension." Eighty college students read a technical text consisting of three main parts framed by an introduction and summary and containing orthographic and typing errors. Subjects were then asked to reproduce in writing as much of the text as they could remember and to complete a comprehension test. Analyses results indicated that the postulated ranks of orienting tasks in the hypothesis and thus depth of comprehension were not immediately visible. Prior knowledge was a relevant variable in text processing. Task orientation influenced the thematic coherence and organization of reproduction. While the study confirmed the difference between low-semantic and high-semantic orientation tasks, it was unable to do the same for the differentiation of depth of processing at the semantic-inferential level. Tables of data and a 6-page bibliography are included. (HTH)

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INFLUENCING DEPTH OF PROCESSING IN READING

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SUMMARY

Depth of processing is a construct used in many instructional approaches for the improvement of text comprehension. Links to a theory of text processing, however, are missing. Within the levels-of-processing approach a concept of processing as a continuum depth is developed. The comprehension continuum is seen as a function of the number and type of inferential processes at the semantic level, in particular, of elaborative processes. Some possibilities are shown, as to how depth of processing may be influenced by text structure, task orientation during reading and by training learning strategies. An experiment within a fairly natural setting demonstrates how various task orientations influence some of the cues (indicators) of processing depth, such as qualitative and quantitative recall measures as well as the answers to questions of comprehension.

0. INTRODUCTION AND OVERVIEW

Everyday and pedagogical experiences demonstrate, that different levels and degrees of text comprehension can be reached during reading. One distinguishes between a superficial and a deeper text comprehension. With the notion of a deeper comprehension one associates a more intensive occupation with the content of the text and based upon this assumption a better recall performance.

In this report the concept of depth of processing will be defined theoretically and empirically more precisely. The first part of the report will deal with approaches examining the relationships of different comprehension levels and the corresponding learning results. Within the frame of the levels-of-processing approach in memory research a definition of depth of processing will be suggested and the respective methodological problems discussed. This is followed by an arrangement of possibilities for the promotion of processing depth. The second part of the paper discusses the empirical study where attempts were made to influence depth of processing by utilizing orienting tasks.

1. ABOUT THE CONCEPT "DEPTH OF COMPREHENSION"

The following overview will not concern itself with all existing approaches of depth comprehension but serves the purpose of dealing with problem orientations as well as differentiating the issues more precisely.

1.1 Approaches from Instructional Psychology

The instructional approaches described here are interested in influencing text processing in a specific manner resulting in a more effective learning. The studies in question are empirically and experimentally screened studies trying to find correlations between learning activities and learning results. Even though these various approaches possess different terminology and accentuations they are all based on this simple schema shown in Figure 1.

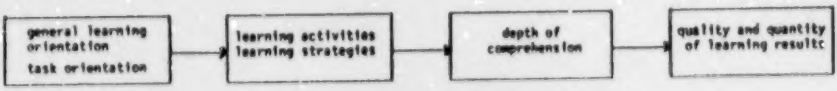

Fig. 1: Schema of instructional approaches

Certain general learning orientations or specific task orientations lead to learning activities, i.e. learning strategies, which influence through the construct "depth of comprehension", quantity and quality in learning performance. Depending upon developmental, differential, or applied psychological orientation, differing amounts of attention and differentiation are applied to the respective components. Some of these approaches will be discussed briefly (summarized Ford, 1981; Watkins, 1983; Schmeck, 1983).

Marton & Säljö (1976a, 1976b) and co-workers did a series of studies where students, serving as subjects read scientific texts. The reading of the text was followed by questions pertaining to the text and about the subject's procedure of text processing which the subjects had to answer. Based on the thematic analysis of the learning results Marton & Säljö first distinguished between four, and then through a combination, two qualitative levels of outcome, to which two processing strategies were assigned empirically:

description oriented: The reader directs his attention towards memorizing the text, i.e. he concentrates on the presented facts. The learning outcome exhibits a superficial, fact oriented processing (surface-level-processing).

conclusion oriented: The reader tries to understand what the author is conveying, i.e. he is critically evaluating presented contents and arguments. The learning outcome consists of interrelations and conclusions and exhibits deeper processing (deep-level-processing).

Marton & Säljö were able to demonstrate, that both kinds of processing are dependent on the reader's task orientation, i.e. which kind of test the reader anticipates.

A comparable classification into surface-level and deep-level-processing is done by Pask (1976). Moreover he assumes the existence of a third type of learner, namely one who is able, depending on task orientation, of applying his learning strategies in a flexible manner:

operation learning: the learner proceeds serially, i.e. sentence after sentence, and concentrate on the individual facts.

comprehension learning: the reader tries to extract the whole structure, whereby he goes beyond the text's content.

versatile learning: depending on task orientation one or the other learning strategy is applied.

Somewhat more differentiated in the measurement of the decisive variables are the research approaches of Entwistle (1981), Biggs (1979), and Schmeck (1983).

A careful assessment of applied learning technics in reading was done by Entwistle, Hanley & Hounsell (1979) with questionnaires about study motivations and study behavior (Lancaster Inventory). With a factorial analysis they determined three study orientations, each corresponding to a specific motivation and a specific learning strategy:

reproducing: The reader concentrates his attention on retention, applies superficial (surface-level) strategies and is extrinsically motivated (fear of failure).

meaning: The reader is oriented towards personal comprehension, applies deep-level learning strategies and is intrinsically motivated.

achieving: The reader orients his attention on each separate study goal and changes strategies accordingly. He is extrinsically motivated (expectation of success).

A similar research program is persued by Biggs (1979) and his co-workers. They also developed a questionnaire for registration of study behavior (Study Process Questionnaire) and did a factor analysis of the answers. Again three factors resulted with cognitive and motivational components:

utilizing: The reader learns the facts and processes them superficially. He is extrinsically motivated (fear of failure).

internalizing: The reader is oriented towards comprehending meaning and assimilating it with prior knowledge, i.e. he is processing on a deeper level. The reader is intrinsically motivated.

achieving: Of major importance here is the extrinsic, success oriented motivation, which selects the appropriate learning strategy.

Biggs also developed a measure for qualitative learning performance (Structure of the Observed Learning Outcome = SOLO). Students had to read a text and to write down answers to questions in a similar way as students did in Marton & Säljö's experiment. The essays were then divided by trained raters into five categories:

prestructural: The answer contains no or only irrelevant information about the read text, and is not based on comprehension.

unistructural: The answer contains relevant information, but leaves modifying and contradictory contents out. The subject matter is extremely simplified.

multistructural: The answer contains several relevant contents, total information contained in the text, and correlates it.

extended abstract: The answer goes beyond the contained information of the text. The reader generalizes and searches for premisses, counter-arguments and further facts.

Biggs examined the relationship between the results of the Study Process Questionnaire and SOLO. He found a partial corroboration for his hypothesis, that students with the orientation 'utilizing' reach a more superficial understanding than the students with the orientation 'internalizing'.

If one reviews these approaches one can realize that they have some common factors. All authors differentiate between two basic types of processing: a superficial process oriented towards retention of facts, and a deeper process oriented towards comprehension of relationships. Secondly they assume, that both processes don't have to represent rigid learning styles, but can be applied in a flexible manner depending on task orientation. Therefore they also assume the additional existence of a combination of the two types, which has at its disposal both types of processing and uses them accordingly. Nevertheless the question still remains whether this division represents an artificial dichotomization of a continuous variable. There is reason to believe that Biggs' SOLO taxonomy 'comprehension' is a continuum of increasing complexity and interrelatedness, and thus could represent the amount of processing. The introduced approaches do not base their studies on any theory of text processing, where cognitive comprehension processes are elaborated. Consequently descriptions of learning strategies remain vague, even if they are considered as samples representing specific processes.

Schmeck et al. (summarized Schmeck, 1983) take this approach one step further but also start by registering study behavior. The items of their Inventory of Learning Process were constructed by three memory-and-learning experts utilizing newer theoretical findings. By means of factorial analysis they extracted four scales, where each learning strategy is supposed to be represented as a sample (pattern) of specific processing. The scale designations are intuitive and do not refer to any processing theory.

Deep processing: A reader attaining a high score on this scale occupies himself with the concepts represented: he categorizes and organizes, he compares the concepts with other concepts, he evaluates their coming together, etc. Thus he combines the new information with his conceptual prior knowledge. The scale is narrower than Marton & Säljö's deep-level processing.

Elaborative processing: A reader receiving a high score on this scale translates the new information into his own terminology, searches for examples existing in his own experience, compares the information with situations in his life, and uses visual imagery. Elaborative processing is defined here as the active combination of new knowledge with the reader's life experience.

Fact retention: A reader with a high score on this scale concentrates on retaining details and facts.

Methodological study: Readers receiving high scores on this scale, make extensive use of study techniques such as taking notes, underlining, answering questions, etc. Their performance is generally poor with the scales 'deep processing' and 'elaborative processing' and therefore they try to compensate by doing more work.
With numerous studies and with satisfying results Schmeck et al. examined the reliability and validity of their measuring instruments. Even with the classification of four learning strategies one could rediscover the already familiar-tripartite division, if one adds the scales 'deep processing' and 'elaborative processing' together. Even though both scales correlate (.45), Schmeck insists that they remain separate. According to him both scales evaluate the information in a different manner: deep processing is a conceptional analysis and elaborative processing is the confrontation with personal experiences. Schmeck also deviates from the other approaches in this respect: he does not assume that processing can be divided into surface and deep processing, but believes processing to be a continuum of increasing processing intensity. Subsequently receiving a high score on the 'fact retention' scale does not have to be an indication for surface processing as is assumed in the other approaches. It only signifies that the reader concentrated especially on facts and details, which does not exclude the fact that he may also have done deep and elaborative processing. Actually 'deep processing' and 'elaborative processing' also correlate (0.39). If anything, Schmeck's scale 'methodological study' may agree with Entwistle and Biggs' orientation 'achieving'. Common to all these scales is that they can identify the fearful adapted, success oriented learner.

In the construction of his learning inventory Schmeck does consider more recent developments and findings in cognition and memory, but nevertheless his approach is correlative without cognitively filling out the construct of depth of comprehension.

1.2 Memory Approach

The authors, which were mentioned in the previous paragraphs, did recognize the deficit in the processing theory and consequently refer in their last publications frequently to the levels-of-processing approach, which is supposed to constitute the cognitive basis for their findings. The levels-of-processing approach seems to be really suited for registering the phenomenon of different processing levels. It presents a theoretical frame for processing and memory processes and was originally developed for learning lists of words and sentences.

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Later it was transferred to learning with texts (Dooling & Christiaansen, 1977; Kintsch, 1979). We will not discuss the numerous discussions of this approach in detail, since it refers mostly to experiments dealing with learning material below the text level (see Cermak & Craik, 1979). Subsequently only those theoretical assumptions are presented which are important for text processing and the concept of depth of comprehension.

1.2.1 PROCESSING DIMENSIONS

The levels-of-processing approach distinguishes between two dimensions of information processing. The qualitative processing dimension is called depth of processing, the quantitative dimension spread of processing.

Depth of processing: The presented information is analyzed on different levels where specific encoding processes occur. Thus one can determine a functional hierarchy and a succession from the sensoric to the semantic level. Kintsch (1979) differentiates between the following levels, represented in Figure 2, whose processing leaves specific traces behind.

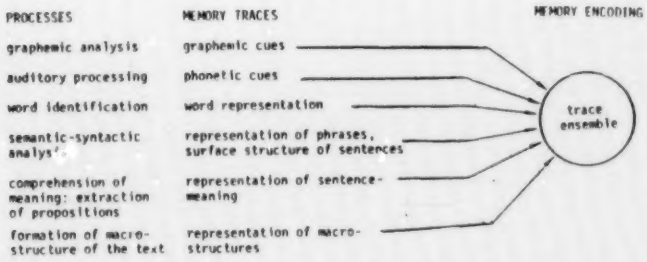

Fig. 2: Levels of text processing according to Kintsch (1979)

The actual processing of the experienced reader does not maintain this functional succession, but consists of parallel bottom up and top down processes (Frederiksen, 1977). Depth of processing refers to the respective level reached.

Spread of processing: Quantitatively, processing can either be larger or smaller on each level, depending on how many processing operations are executed with the information. These quantitative dimensions are also called 'elaborative processing' (Craik, 1979).

Figure 3 combines both processing dimensions of the levels-of-processing approach. An important main assumption of this approach implies that the kind of memory trace formed during processing, its intensity and permanence, is a function of the occurred encoding processes, i.e. a representation of depth of processing and spread of processing. Therefore the memory trace can be viewed as an ensemble of encoding processes that have been conceived. Since comprehension and memory processes are indivisible, the quality and quantity of retention performance (recall or recognition) do allow conclusions about the processes that have occurred.

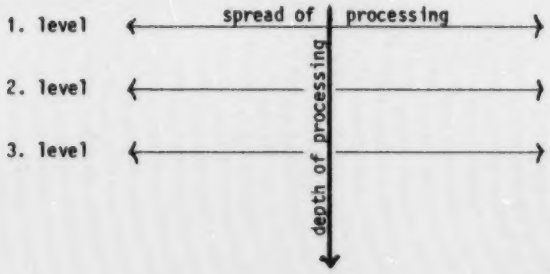

Fig. 3: Processing dimensions in the levels-of-processing approach

1.2.2 INFERENTIAL PROCESSING

In reading comprehension the semantic level of processing is necessarily reached, since 'below' it no coherent and subsequently no comprehensible representation of the text would be possible. Differences in comprehension can only be caused by the spread of processing at the semantic level. The spread of processing at this level can contain a multitude of processes, we are dealing with different kinds of conclusions based on prior knowledge. This is the reason why one speaks of inferential processing (Frederiksen, 1977b). One text segment activates one schema or several, which will disclose new propositions not existing in the text. Two kinds of processes can be distinguished according to their function, namely reductive and elaborative inferences (Ballstaedt, Mandl, Schnotz & Tergan, 1981):

Reductive inferences condense text knowledge to a semantic macrostructure by using operations of generalization and abstraction. This macrostructure forms a coherent summary of the most important contents of the text from the reader's point of view. Cognitive operations in reductive processing have mostly been studied by van Dijk (1980). Brown & Day (1983) inform us about the development of reductive processes. Assumingly reductive processing plays an important role in the formation and alteration of schemata, which come into being through generalized experiences. In addition, semantic macrostructures serve as 'plans' for the reconstruction of text contents.

Elaborative inferences enlarge text knowledge through associative processes across the actualization of connected and hierarchical arranged schemata. They establish links between text knowledge and prior knowledge and enrich the text with additional contents (Anderson & Reder, 1979). Because of the differences in knowledge and experience, elaborative processing can be extremely idiosyncratic. In the comprehension process both kinds of inferences supplement each other. Elaborative processing creates multiple links with prior knowledge, and reductive processing ensures that economic limits are restricted to essentials. The former represents the divergent aspect, and the latter the convergent aspect of comprehension.

Besides elaborative or reductive inferences one can find in the protocols of loud thinking statements that contain a mixture of the two.

For this sentence

(1) The northern viper, grass snake, and blind worm are endangered species

the following statements were made:

(2) Reptiles are endangered species.
(3) The bite of a northern viper is deadly.
(4) Native reptiles will soon be exterminated.

Comment (2) represents a true reductive inference, (3) a true elaborative inference, and observation (4) a mixture, where a reductive generalization is combined with an elaborative conclusion (extermination as the cause for extinction).

Even though reductive and elaborative processing are very closely interwoven with each other, each process serves different reading intentions and reading strategies. Consequently comprehension research usually examined these processes individually and not together. With respect to different comprehension levels, the elaborative processing is the decisive factor. Anderson & Reder formulated the following hypothesis within the levels-of-processing approach: "We hypothesize that manipulations designed to affect what has been referred to as depth of processing are having their effect by changing the number and type of elaborations stored. We believe that subjects typically store much more than the input presented in the memory situation". Later on this general hypothesis was elaborated into a script - elaboration theory by the authors (Anderson, 1980, 1983; Reder, 1980). The elaborative inferences are made possible through activated scripts which are complex schemata containing knowledge about stereotyped sequences of actions and events (Schank & Abelson, 1977). The most elaborate approach to describe simultaneously occurring cognitive operations was attempted by Anderson (1983). The production of coherence in a text and between text and prior knowledge is viewed as the main function of elaborative processing. Reder (1980) has collected numerous outcomes, which demonstrated improved retention when elaborated know-

ledge structures were available. The positive effect of elaborative reading strategies, i.e. study strategies, can be considered as confirmed (Mayer, 1980; Weinstein, 1978; Weinstein et al., 1979). Anderson (1980) gives two reasons for improved retention when using elaborative processing. They are based on the assumption that knowledge in our memory is represented in the form of a semantic network.

(1) An existing knot within an elaborated knowledge structure possesses a greater chance of being found again, since it exhibits more connectives to surrounding knots. These connections could serve as alternate retrieval paths.
(2) A non-existing knot can be more easily ascertained within an existing elaborated knowledge structure through the surrounding knots, i.e. it can be reconstructed.

Thus, within an elaborated knowledge structure information can be maintained better, since a reconstruction has more reference points that can be used.

The advantages of elaborative processing indicate that the number of elaborated inferences play a role in the process of comprehension. When elaborative processing is increased, at first retention will attain its optimum, and then start to decrease: The person who elaborates very little, does not attach the new knowledge very well to prior knowledge; while the person elaborating extensively runs into problems when attempting the reconstruction of the text (Mandl & Ballstaedt, 1982). Just as important as the amount of elaborated inferences, are their kind and quality. A number of studies implies the existence of two types of inferences, those which promote learning and those which hinder learning. On this occasion two aspects turned out to be important with respect to elaborative processing:

Integrative value: Inferences are then useful for retention when they create a semantically coherent context for the presented information. In other words: If they establish a very close relationship between prior knowledge and the text (Stein, Morris & Bransford, 1978; Morris, Stein & Bransford, 1979; Auble & Franks, 1978; Reder, 1982; Bradshaw & Anderson, 1982).

Contrast value: Jacoby & Craig (1979) formulated the 'distinctiveness of encoding' hypothesis, where elaborative processing is most effective if one can distinguish the resulting memory trace clearly from the other memory traces (Craik, 1979; Klein & Saltz, 1976; Glover et al., 1981; Glover, Bruning & Plake, 1982).

In sum, one can determine that an elaborative knowledge structure becomes optimal when it possesses many coherent connections which can be clearly distinguished from other knowledge structures. From this approach the concept of a continuous depth of comprehension can be deduced. Depth of comprehension is a function of inferential processing, but moreover specifically of elaborative processing. The learning of a text leads to a continuously deeper comprehension the more processes occur in favour of coherence.

1.2.3 MEASURING COMPREHENSION

Differential measurements of text comprehension is still a problematic area (compare Carroll, 1972; Voss, Tyler & Bisanz, 1982). The methods foremostly used are particularly insufficient when different degrees of comprehension at the semantic level, or the quality of comprehension is supposed to be registered. Even within the levels-of-processing approach one seems to be satisfied by measuring retention performance, utilizing the number of correctly reproduced items as measure of depth of comprehension. This of course does not represent a particularly valid measure for depth of comprehension. Consequently some ideas and suggestions are presented how register various degrees of depth of comprehension methodologically.

Free recall (reproduction). The quantitative evaluation of recall protocols (mostly counting the reproduced propositions) remains the simplest method of approaching the registration of depth of comprehension. Nevertheless it cannot be overlooked, even with the assumptions of the levels-of-processing approach, that the relationship between comprehension and retention has not been sufficiently clarified: Not everything that is comprehended can be retained, and that which is retained is not always comprehended (Ortony, 1978; Schwarz, 1981). In order to get a better understanding of the occurring processes one should perform also a qualitative analysis of the protocols besides the quantitative analysis. The examination of macropropositions contained in the reproduced text, i.e. the reproduced main ideas offers one possibility. Also the coherence of the reproduction or its thematic sequencing in contrast to the original text version can be useful cues for occurred processes. Some examples of a qualitative analysis can be found in the empirical section of this paper (section 2.3).

Comprehension questions. When measuring depth of comprehension, knowledge questions demanding only recall or recognition of text parts, are quite useless. A valid comprehension test should consist of questions demanding additional processing. A taxonomy of this type of comprehension questions should be based on the taxonomy of inferences possible within the comprehension process. Such a taxonomy is only available rudimentarily for expository texts (Crothers, 1979; Frederiksen et al., 1978; Goetz, 1979).
Basically two types of questions can be considered: Firstly questions that require the linking together of relationships. That exist in the text without being explicitly stated. To this purpose, relationships may have to be corrected between passages that are far apart from each other. Reder & Anderson (1980) call these questions 'indirect questions'. The second type of questions would demand the connection of relationships extending beyond the text where the actualization of prior knowledge is required.
Naturally, more demanding types of multiple choice questions can also be utilized as valid cues for depth of comprehension (compare Groeben, 1982; Klauer, 1979).

Essay. The possibility used quite frequently up to now when learning with expository texts, is to write an essay on a questions related to the topic (Marton & Säljö, 1976 a,b; Biggs, 1979). The question can concern itself with matters of application, or the question can deal with text information in such a manner that it has to be used in a new perspective. The construction of an essay goes beyond recall as it demands the usage of acquired knowledge within a new argumentation context. However, the evaluation of written essays is difficult. Besides the examination as to the amount of text knowledge and amount of prior knowledge that has gone into the answer, evaluation scales are needed to assess the complexity of the essay. One possibility would be the application of the SOLO scale by Biggs (1979), or the scales measuring cognitive complexity (Schroder, Driver & Streufert, 1975; Streufert, 1978). These few remarks demonstrate that methodological creativity is still being challenged even after years of research when dealing with the differential analysis of comprehension processes. As long as an optimal method cannot be used for the specific goal, at least several supplementary methods should be utilized, since every measure analyzes different aspects of comprehension.

1.3 Influencing Depth of Comprehension

Within the reader-text-interaction, where learning results are determined by text attributes and reader attributes, one can principally start with the reader or with the text to improve comprehension (compare Ballstaedt, Mandl, Schnotz & Tergan, 1981; Groeben, 1982). Basically all measures broadening processing at the semantic level contribute towards depth of comprehension. However, in this segment only those possibilities will be mentioned which promote decisive elaborative processing.

Moreover, greater importance is attached to the possibilities of the reader than to the possibilities of influencing through text design.

1.3.1 TEXT DESIGN

When the generation of an elaborative context improves the comprehension and retention of information, two methods of organization are possible: The first possibility is where the author can try to stimulate the generation of elaborative context by placing advance organizers or additional questions in the text. Reder (1980) is of the opinion that the often demonstrated effects of such learning aids can be traced back to elaborative processing.

The second possibility consists of delivering elaborative contexts as examples and excursions simultaneously within the text. This 'embellishment' by the author is however not unproblematic, as a study done by Reder & Anderson (1980, 1982) demonstrates. They compared the learning performances of subjects, presented either with an instructional text or a text summary. The text was viewed as the elaborated and enriched version of the summary. Nevertheless, and to everybody's surprise, all outcomes showed always the advantages for learning to be on the side of the text summary, even with different measures and after different time intervals. These results seem to speak against the effect of elaborative contexts. If one accepts this conclusion one misses however the essential difference, which can exist between self-generated elaborations and presented elaborations. Whereas self-generated elaborations per definition result from existing prior knowledge, a reference point to prior knowledge does not necessarily have to exist when the elaborations are offered by the author. Is the author mistaken about the reader's prior knowledge then his elaborative enrichments, excursions and examples can present additional learning material and exercise a detrimental effect non the learning of the main ideas contained in the text (Reder, 1982).

Naturally also other attributes of text organization can contribute to the semantic and specifically to elaborative processing. For example, illustrations can also fulfill the function of elaborative context (Stone et al., 1981). Schnotz (1984) could demonstrate that the manner of sequencing an instructional text has an effect upon the inferential activity during studying.

1.3.2 TASK ORIENTATION

One simple possibility of influencing the encoding processes, is by creating tasks to which processing is oriented (see Rothkopf & Billington, 1979). Two variants can be distinguished. Orienting tasks, i.e. tasks which the reader solves while reading, or test expectations, i.e. tasks supposed to take place after the reading and which act as expectations.

Orienting tasks. Tasks which are supposed to be executed during the encoding time are presented within the levels-of-processing approach, in order to induce a specific depth of processing. This depth of processing is determined by giving an unexpected retention test. Thus we are dealing with a paradigma of incidental learning. Often non-semantic task orientations are compared with semantic task orientations, such as the underlining of all 'e's' in a text with the underlining of the most important sentences, whereby the semantic orienting task always leads to a deeper processing. Regarding texts only a few studies have been done so far (Schallert, 1976; Arkes, Schumacher & Gardner, 1976; Zimmer, 1978).

Test expectations. A second possibility exists by using instructions containing the task the reader is supposed to execute after the reading, such as writing a summary or reproducing the original text version as completely as possible. In several studies it could be shown that the anticipated usage of the text contents actually influenced the encoding process (d'Ydewalle, 1981; Schwartz, 1981; d'Ydewalle, Swerts & DeCorte, 1982). D'Ydewalle & Rosselle (1978) demonstrated for example that the reader expecting a multiple choice test utilizes a superficial processing strategy oriented towards retaining details. If the reader is, however, expecting open questions he will utilize a deeper processing strategy which extracts the main ideas.
Both possibilities of task orientation represent experimental, technical variants which basically do not differ from each other. Whether one reads and has to underline the basic themes, or whether one reads in order to summarize should principally not make a difference. The utilization of orientation tasks when reading is simple and occurs

frequently during teaching. It remains, however, unsatisfactory from the cognitive perspective since one remains unsure as to which operations and strategies the reader actually does apply (Postman, Thomkins & Gray, 1978).

1.3.3 READING-AND-LEARNING STRATEGIES

All developed and successfully implemented reading instructions and learning strategy programs so far contain also measures which are supposed to improve elaborative processing. Besides the general demand of relating text knowledge with prior knowledge the programs contain instructions asking for the self-initiative of the reader especially for generating questions, elaborative contexts, and visual imagery.

Questions. Self-addressed questions at the subject matter contained in the text intensify the interaction between reader and text in the sense of an enhanced elaborated process (Andre & Anderson, 1978). Questions directed at the text and about the text presuppose available knowledge as well as knowledge concerning knowledge gaps (Miyale & Noeman, 1979; Flammer, 1980).

Elaborative contexts. What is meant here is above all the search for concrete examples existing in prior knowledge (compare Mandl, Schnotz & Tergan, 1983). However one can also envisage other forms of knowledge enrichment such as excursions, comparisons, and descriptions.

Visual imagery. The value of improving learning through visual imagery has only been shown so far with classical mnemonic techniques and with the memorization of word lists and sentences. Some studies point towards an improved comprehension performance when visual imagery is generated (Philipchalk, 1972; Morris & Reid, 1972). However, with longer technical texts, imagery may only occur sporadically when concentrate and illustrative text segments are offered.

These three possibilities for improving elaborative processing have always been used in pedagogy and didactics, nevertheless they are only now receiving their theoretically foundation in cognitive psychology. In one form or another they appear in all learning strategy programs.

Consequently the SQ4R-method of reading (Thomas & Robinson, 1972) contains instructions to address questions at the themes of the respective text (Q = questions) which are to be answered during reading or after reading (R1 = read, R4 = review). Furthermore it asks, that the read material be connected with prior knowledge and that the readers try to find corresponding examples (R2 = reflect).
Also the comprehension strategies contained in Dansereau's program (1978, Dansereau et al., 1979) demand self-addressed questions and the connection with prior knowledge. The same holds true for study strategies utilized before, during, and after reading which were constructed by Anderson (1980).
Weinstein (1978) constructed a training program only for elaborative skills. She defines elaborative skills as any kind of intensive activity associated with learning material, i.e. also such study habits which may not add any new information. When studying a text the following skills are practised: The generation of visual imagery, analogy formation, paraphrasing, formation of inferences. Trained ninth grade students exhibited after one month a better reading comprehension than an untrained group. Other studies about the influence of elaborative learning strategies can be found in Mayer (1980), and Gagnè et al. (1980).

One level higher and going beyond the cited reading strategy programs is the concept of the critical-creative reading, which Groeben (1982) defines as the highest level of a reader's constructive activity. The cognitive processes utilized in the critical creative reading of technical texts contain a lot of additional elaborative processing, with which the reader determines his point of view in comparison to the text. A large list of operational skills regarding critical-creative reading was created by Wolf et al. (1968). The relevant skills concern for example recognition and evaluation of the validity of the hypotheses, arguments, and conclusions, the differentiation of denotative and connotative meanings, the recognition of rhetorical dodging, etc. Altogether the critical creative reading represents the evaluative portion of text processing. A prepared learning strategy program for critical-creative reading does not exist at this time. However, individual techniques are being rehearsed in didactics of graduated reading development especially in the teaching of literature (Braun, 1971; Hussong, 1973).

2. THE EXPERIMENT

2.1 RESEARCH QUESTIONS

Based on the background of the depth of comprehension approach an experiment was designed with the goal of inducing various degrees of depth of processing at the semantic inferential level through orientating tasks. In contrast to existing studies using the framework of the levels-of-processing approach an ecologically valid learning situation containing meaningful reading tasks and usual instructional texts was created.

2.1.1 ORIENTING TASKS

Most available studies used, orientating tasks which never take place during normal reading, such as underlining all the 'e's' in a text. Consequently five tasks were chosen which definitely play a role in everyday reading or in the pedagogy of advanced reading development. With every orientating task one can formulate suppositions about their influence on depth of comprehension due to existing knowledge about text processing.

Error correction. The task is to read the text to find all orthographically mistakes and correct them. When the reader assumes that these errors are either orthographic or typing mistakes, the proof reading occurs mostly at the graphemic-lexical level. Processes forming coherence or connections with prior knowledge are not absolutely necessary, even though the reader doing the proof reading absorbs always something of the text content. Proof reading lies at the lowest threshold of the semantic level, and depth of processing will accordingly be superficial.

Summary. The task is to read the text, underline the most important contents and then give a summary of the text. The prerequisite for a summary is that the individual propositions are examined whether they are important or unimportant. For the propositions which have been

selected as important a coherent macrostructure has to be created and then memorized. This orientation task favors reductive processing in comparison to elaborative processing.

Reproduction. The reading task here is to reproduce the text contents as completely as possible. A total reproduction would in the ideal case also very likely encompass the construction of a macrostructure functioning as a retrieval aid for subordinated information. However, not only propositions contained in the macrostructure would have to be memorized but also the additional information. Subsequently the amount of processing should be greater than in summarization.

Comprehension. The task is to read the text, comprehend it and underline those passages which are difficult to comprehend or totally incomprehensible. This task demands the construction of a coherent text representation at the micro-and macro processing levels. The information has to be integrated with prior knowledge, i.e. elaborative processing is required.
Hence comprehension requirements exceed those of summarization and reproduction and lead to deeper processing.

Critical evaluation. The task is to give a critical opinion about the read text. Problematic passages are supposed to be underlined. Based on the concept of critical-creative reading a further evaluative step is executed in this orienting task: thematic and formal text attributes are judged according to different values and criteria. This evaluation can be viewed as additional elaborative processing, which continues to deepen the attained depth of processing reached through comprehension.

The ideas discussed about processing with regard to orienting tasks are by no means complete, but they point towards a continuum of ever increasing requirements with respect to text processing.

2.1.2 COMPREHENSION MEASURES

Problems pertaining to the analysis of depth of comprehension were already dealt with in section 1.2.3. In order to record the depth of comprehension in quantitative and qualitative measures a written reproduction of the text, and a comprehension test consisting of open questions was used. The dependent variables were five measures, i.e. indicators of depth of comprehension:

Reproduction (recall).
- amount of correctly reproduced propositions
- amount of correctly reproduced main ideas
- thematic coherence with regard to text
- sequence of propositions in comparison to the text

Comprehension questions.
- the sum of score points attained in the comprehension questionnaire.

The individual measures will be described in detail in section 2.3.

2.1.3 HYPOTHESES

With each orienting task assumptions were made about their cognitive requirements and the subsequently attained level of depth of comprehension. Therefore the comprehension depth would increase from the task 'error correction' to 'summary' to 'reproduction' to 'comprehension' and finally would reach the deepest level at 'critical evaluation'. The following hypothetical structure can thus be assumed for all five measures:

error correction < summarization < reproduction < comprehension < critical evaluation

The most superficial reading will occur for "error correction" and the deepest reading will be done for "critical evaluation". In between the two lie the tasks "summarization", "reproduction", and "compre-

hension". Ranked this way their arrangement carries serious misgivings. The reason for this is the fact that processing occurring here is partially identical and therefore the results almost show no differences and when using rough comprehension measures are invisible.

2.2 Experimental Procedure

2.2.1 Materials

Comparable studies utilized mostly short and banal texts. In order to simulate a fairly natural learning setting a technical text about the psychology of emotions was written which adhered closely to the text book of Schmidt-Atzert (1982). The text consisted of 3149 words, i.e. its length corresponded to approximately 12 type-written pages. The text arrangement contained three main segments and was framed by an introduction and a summary (advance organizer) as well as a perspective outlook. The content structure looked as follows:

1. Introduction: About the history of the psychology of emotions
2. Advance organizer
3. Emotions as a subjective experience
   - definition and methods
   - research questions and results
   - research study as an example
4. Emotions as a physiological reaction
   - definition and methods
   - research questions and results
   - research study as an example
5. Emotions as behavior
   - definitions and methods
   - research questions and results
   - research study as an example
6. Perspective outlook

For the orienting task 'error correction' 40 orthographic-and-typing errors were made, whose discovery did not require more abstract semantic processing.

2.2.2 SUBJECTS

Subjects were 80 students from the University of Tübingen. They were majors in language, law, theology, and art history in arts and social studies, i.e., and were paid for their participation.

2.2.3 DESIGN AND PROCEDURE

First phase. Relevant learning prerequisites such as prior knowledge, verbal intelligence, and verbal creativity were measured. For establishing domain-specific prior knowledge the subjects were given ten open questions dealing with emotions which referred to the main contents contained in the experimental text. The evaluation was done by counting the utilized propositions contained in the answers. The control variable verbal intelligence was ascertained with the aid of subtests of the Intelligence-Structure-Test by Amthauer (IST), as well as the Performance Evaluation test by Horn (LPS). Verbal creativity also served as a control variable and was established with Schoppe's (1976) creativity test. Based on the domain-specific prior knowledge (i.e. the scores in the prior knowledge test) 40 subjects with high prior knowledge (above the median), and 40 subjects with low prior knowledge (below the median) were randomly divided into five groups. For the groups, constituted according to prior knowledge, no differences could be detected with respect to verbal intelligence and verbal creativity. Therefore the comparability of the experimental groups is assured. Figure 4 shows the experimental design.

	error correction	summary	reproduction	comprehension	critical evaluation
domain specific prior knowledge (high)	n = 8				
domain specific prior knowledge (low)	n = 8				

Fig. 4: Experimental design

Second phase. The actual reading procedure occurred one week later. Each group of subjects was given one hour to read the text according to the individual orienting task. The experiment was carried out with groups that were not identical with the experimental groups, i.e. in each group there were subjects with different orienting tasks. The reading was followed by a break and then subjects were asked to reproduce the text in writing as completely as possible. This was not expected by the subjects. They were informed that the verbal quality was of no importance, only the memorized contents. Time allowed for reproduction was 45 minutes. Immediately following this procedure the subjects had to take a comprehension test consisting of 45 open questions. The test consisted of some knowledge questions dealing directly with information contained in the text, but mostly of indirect questions. Here subjects had to form links between different text passages or draw conclusions. Time allowed was one hour. The experimental material utilized such as text, instructions, prior knowledge test, and comprehension questions had been tested for their usefulness in a pretest. Also the amount of time allowed for the various tasks had been determined on the basis of experiences made in the pretest.

2.3 Scoring Procedure and Results

2.3.1 Recall Protocols

The evaluation of the recall protocols was based on a list of 306 idea units into which the experimental text was divided.

One idea unit represents a thematic information complex, which approximately corresponds to a main sentence. An idea unit spans a superordinated proposition with its subordinated propositions. The first sentence in the experimental text can be divided into two idea units:

> Since the beginning of time man has thought about emotions, feelings, affects and moods, for they belong to the most intense experiences of daily life
>
> (1) Since the beginning of time man has thought about emotions.
> (2) Emotions belong to the most intense experiences of daily life.

Amount of idea units. First as a quantitative measure for comprehension the correctly reproduced idea units were counted. Table 1 shows the results of a two factorial analysis of variance about the influence of prior knowledge and task orientation on the amount of reproduced idea units. The values found in the table are standardized. Only prior knowledge has a significant effect, neither task orientation nor the interaction of the two factors. The group 'error correction' scored relatively low,as was expected. A surprise was also the poor performance of the 'reproduction' group, since actually only with this group, task and test were in concordance, and one could have expected a better outcome (compare d'Ydewalle & Rosselle, 1978). Also contrary to the hypothesis, the group 'critical evaluation' showed a tendentially poor performance.

Table 1: Results of the two factorial analysis of variance concerning the influence of task orientation (error correction, summarization, reproduction, comprehension, critical evaluation) and prior knowledge (high/low) upon reproduction performance: amount of idea units

source of variance	F	sig
task orientation	1.972	ns(p = .12)
prior knowledge	5.560	s(p < .05)
interaction	0.368	ns

	Task orientation					
	error-correction	summary	reproduction	comprehension	critical evaluation	Σ
prior knowledge (high)	99,0	105,5	101,6	104,9	101,3	102,5
prior knowledge (low)	92,2	97,6	98,3	104,0	94,6	97,3
Σ	95,6	101,6	99,9	104,5	98,0	100,0

Amount of main ideas. Five experts selected the main ideas from the 306 idea units contained in the text. If at least three experts agreed upon one idea unit then it was incorporated in the macrostructure. The macrostructure consisted of 54 coherent idea units. Table 2 shows the results of a two factorial analysis of variance about the influence of prior knowledge and task orientation upon the amount of reproduced main ideas. Almost the same pattern of results can be found here as in table 1 except that task orientation nearly became significant. Prior knowledge is significant, interaction is not. The group 'error correction' once again attained the lowest score. Tendentially the group 'summarization' exhibits the best performance while the group 'critical evaluation' performed contrary to the hypothesis, i.e. had a relative low performance score.

Table 2: Results of the two factorial analysis of variance concerning the influence of task orientation (error correction, summarization, reproduction, comprehension, critical evaluation) and prior knowledge (high/low) upon reproduction performance: amount of main ideas

source of variance	F	sig
task orientation	2.366	ns($p = .06$)
prior knowledge	4.928	s($p < .05$)
interaction	0.933	ns

	Task orientation					
	error-correction	summary	reproduction	comprehension	critical evaluation	Σ
prior knowledge (high)	95,5	104,5	104,4	101,2	106,0	102,3
prior knowledge (low)	91,7	100,8	98,4	102,5	94,7	97,6
Σ	93,6	102,6	101,4	101,8	100,3	99,97

In order to establish further measures for the qualitative description of the reproduction, it was assumed that the reproduction could vary in two ways from the original text version: Either idea units were deleted, or their thematic arrangement had been changed. By comparing the list of idea units of the original text with the list of idea units contained in the reproduction, qualitative measures for accuracy can be deduced. In the following paragraphs two measures will be discussed, nevertheless with the awareness, that they do not represent the optimal solution.

Thematic coherence. A measure of thematic coherence in comparison to the original text would be the amount of transitions from one thematic block to another block within the list of idea units. In the experimental text with six thematic blocks, only five such transitions should occur in the reproduction. If more thematic transitions should occur then this would point towards a poor thematic organization in comparison to the original text. As a measure the number of thematic transitions is divided by the number of recall reproduced idea units.

$$Q_1 = \frac{\text{number of thematic transitions}}{\text{number of reproduced idea units}}$$

The larger the quotient the poorer the thematic organization of the reproduced text. Table 3 shows the results of a two factorial analysis of variance about the influence of task orientation and prior knowledge on the thematic coherence of the reproduction. Task orientation has a significant effect which is only ascribable to group 'error correction' in comparison to the other groups, especially 'summarization' and 'reproduction' (sig. 0.5).

Table 3: Results of the two factorial analysis of variance concerning the influence of task orientation (error correction, summarization, reproduction, comprehension, critical evaluation) and prior knowledge (high/low) on the thematic coherence of reproduction (Q_1)

source of variance	F	sig
task orientation	3.704	s($p < .01$)
prior knowledge	0.266	ns
interaction	0.380	ns

	Task orientation					
	error-correction	summary	reproduction	comprehension	critical evaluation	Σ
prior knowledge (high)	0,23	0,16	0,12	0,12	0,16	0,16
prior knowledge (low)	0,20	0,13	0,14	0,14	0,14	0,15
Σ	0,22	0,15	0,13	0,13	0,15	0,15

Sequence of idea units. Another qualitative measure considers the distances between successive idea units in the reproduced text in comparison to the original text. The quotient can be interpreted as a measure for sequence accuracy against the original text.

$$Q_2 = \frac{\text{sum of the differences between transitions}}{\text{number of transitions (= number of idea units - 1)}}$$

A larger quotient exhibits a more confused sequence when compared with the original text. Table 4 shows that even with this measure of reproduction accuracy task orientation has a significant effect. Here, too, group 'error correction' produces the worst organized reproduction when compared to the original text. The distance of the group 'error correction' to the groups 'reproduction' and 'comprehension' is significant (0.5).

Table 4: Results of the two factorial analysis of variance concerning the influence of task orientation (error correction, summarization, reproduction, comprehension, critical evaluation) and prior knowledge (high/low) on the sequence of idea units (Q_2)

source of variance	F	sig
task orientation	4.019	s($p < .01$)
prior knowledge	0.008	ns
interaction	0.757	ns

	Task orientation					
	error-correction	summary	reproduction	comprehension	critical evaluation	Σ
prior knowledge (high)	23,6	19,4	13,3	14,2	16,7	17,4
prior knowledge (low)	30,9	13,2	13,1	15,5	15,6	17,7
Σ	27,3	16,2	13,2	14,8	16,1	17,5

When interpreting these suggested measures of accuracy one should exercise caution. One problem for both measures is the fact that thematic transitions and great distances between idea units do not necessarily indicate semantic distances. Also a great jump could represent a plausible thematic relationship. Subsequently high quotients could indicate also a deep and coherent processing. A second problem conceals itself behind the strange outcome that prior knowledge has no effect. Obviously the quotients level the differences between high/low prior knowledge and subsequently are poor indicators for depth of comprehension.

2.3.2 COMPREHENSION QUESTIONS

The evaluation of the open questions was done on the basis of correct answers whereby each answer was given points according to its quality: no answer or incorrect answer = 0; partially correct = 1; correct answer = 2. Seven questions were left out of the 45 questions due to an item analysis. Table 5 contains the standardized results. Task orientation and prior knowledge had significant main effects and were evaluated with a two factorial analysis of variance. Again, there was no significant interaction. As with the measures of reproduction here,too, group 'error correction' has the lowest score. Conspicuous is once again the unexpected poor performance of the group 'critical evaluation' in comparison to other groups. The significant effect of task orientation can be traced back to the difference between group 'error correction' and the rest of the groups.

Table 5: Results of the two factorial analysis of variance concerning the influence of task orientation (error correction, summarization, reproduction, comprehension, critical evaluation) and prior knowledge (high/low) on comprehension questions.

source of variance	F	sig
task orientation	7.078	s($p < 0.001$)
prior knowledge	16.666	s($p < 0.001$)
interaction	.133	ns

	Task orientation					
	error-correction	summary	reproduction	comprehension	critical evaluation	Σ
prior knowledge (high)	94,1	105,3	106,4	108,0	105,1	103,8
prior knowledge (low)	87,4	97,2	97,8	102,7	96,2	96,2
Σ	90,7	101,2	102,1	105,4	100,7	100,0

2.4 Discussion

One effect of task orientation can be realized in the qualitative accuracy measure and tendentially in the amount of main ideas, but foremostly and highly significantly in comprehension questions. The postulated ranks of orienting tasks in the hypothesis and thus depth of comprehension are not immediately visible. Prior knowledge as a relevant variable in text processing is confirmed. The interaction between task orientation and prior knowledge ist not significant as a rule. A few remarks should be added to the interpretation of these results. First one should realize that comprehension questions represent a more reliable and accurate measure than reproduction. The written reproduction of a text, especially a lengthier text is demanding and consequently extremely dependent upon motivational factors. Also writing habits certainly play a role. Some people are very thorough while others try to get this unpleasant task finished as quickly as possible. Therefore written reproductions vary considerably with respect to the amount of reproduced ideas. Thus a significant effect of task orientation on amount of reproduced idea units cannot be expected when the texts are complicated and very long.

On the other hand qualitative measures offer a better outlook: The number of main ideas barely misses being significant, with the semantic, rather problematic accuracy measures a main effect is realized: Task orientation influences the thematic coherence and organization of reproduction. However, this effect is only attained because of the existing distance of group 'error correction' to the other groups. This group's performance is in agreement with the hypothetical performance postulated in the hypothesis. But contrary to expectations the group 'critical evaluation' does not have the best performance scores, and the middle groups exhibited, as was feared, hardly any differences. Let us now turn to the comprehension outcomes, which had a highly significant effect on task orientation. If we attempted to reconstruct the postulated ranks, then the group 'error correction' was placed correctly while the group 'critical evaluation' was totally misplaced. Performance of the subjects is poor, below the group 'comprehension'. The reason behind this was later found in an analysis done of the

subjects' processed texts. According to instructions subjects of this group were supposed to write down critical comments on the margins. However, when one takes a look at those margins one realizes immediately that no intensive processing occurred at all. One is left with the impression that text reading proceeded on a superficial level until a problematic text passage was reached. Then the subjects either placed a question mark besides the passage or made the following comments: 'nonsense', 'incomprehensible', or 'inhumane', and this would be the end result of their critical analysis. Thus we were unable of accomplishing our goal of evoking an intense processing manner as we had desired, a process called critical-creative reading. The issued instructions could have been responsible, but more probable the instructions did not meet with any available reading strategies. Thus our 'critical' readers were besides the proof readers our most superficial processors.

The small differentiation between the task orientations 'summarization', 'reproduction', and 'comprehension' in the reproduction asked for by the comprehension questions could indicate that processing depths do not actually differ. Altogether the postulated ranks of processing depth when based on task orientation neither confirm nor repudiate the ascertained results. A follow-up study would have to be done ensuring that the instructions will be followed. Prior strategy training would probably be necessary. The general non-interaction of prior knowledge with task orientation is very difficult to interpret, since it was not expected in the theory. For the task 'error correction' certainly less prior knowledge is needed than for the tasks 'comprehension' or 'critical evaluation'. Nevertheless one should consider that for the reproduction tasks and answering the questionnaire, prior knowledge should be a decisive factor, independent of the original task orientation.

Summarizing one can determine that depth of processing can be influenced by task orientation, keeping the prerequisite in mind, that the task's necessary strategies are available and will also be used. While the study confirmed the difference between low-semantic and high-semantic orientation tasks, it was unable to do the same for the

differentiation of depth of processing at the semantic-inferential level. The reasons are probably that the utilized measures serving as indicators for processing depth, were still too coarse and that instructions were not adhered to properly, i.e. they were not controlled by the experimentor.

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